

High Tc Superconducting Materials and Devices

by

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The high Tc (95K) $Y_1Ba_2Cu_3O_{7-x}$ ceramic materials, initially developed in 1987, are now being extensively investigated for a variety of engineering applications. These applications include such devices as conducting links, rotating and linear bearings, sensors, filters, switches, high Q cavities, magnets and motors. Some of these applications take advantage of the material's ability to lose all electrical resistance at a temperature (T_c) which is easily attainable with liquid nitrogen (77K), while others make use of the repulsion force generated between the magnetic field of a magnet and the superconductor (Meissner effect), and still others exploit the high sensitivity of the superconductive effect to magnetic fields to yield super sensitive magnetic field sensors (SQUIDS).

The superconductor applications which have presently been identified as of most interest to NASA-LaRC are (1) low-noise, low thermal conductivity grounding links for space-related detectors operating in the temperature range from 4K to 80K (SAFIRE), (2) large-area linear Meissner-effect bearings for supporting optical systems in space (IBEX) and (3) sensitive, low-noise sensors and leads for the LaRC cryogenic wind tunnel.

Devices designed for these applications require the development of a number of processing and fabrication technologies which will yield superconducting materials in both bulk and thin film forms. Included among these technologies most specific to the present needs are (1) tapecasting, (2) melt texturing, (3) magnetic field grain alignment, (4) superconductor/polymer composite fabrication, (5) thin film MOD (metal-organic decomposition)

processing, (6) screen printing of thick films and (7) photolithography of thin films.

Efforts this summer have been directed toward developing some of these technologies as in-house capabilities. Accordingly, the overall objective of the program was to establish a high T_c superconductivity laboratory capability at NASA-Langley Research Center and demonstrate this capability by fabricating superconducting 123 material via bulk and thin film processes. Specific objectives included:

1. Order equipment and set up laboratory
2. Prepare 1 kg batches of 123 material via oxide raw materials
3. Construct tapecaster and tapecast 123 material
4. Fabricate 123 grounding link
5. Fabricate 123 composite for Meissner linear bearing
6. Develop 123 thin film processes (nitrates, acetates)
7. Establish T_c and J_c measurement capability
8. Set up COMMERCIAL USE OF SPACE program in superconductivity at LaRC

In general, most of the objectives of the program have been met. One-kilo batches of 123 material have been successfully prepared from in-house laboratory facilities. Powder from this oxide process was used to tapecast material which was subsequently fired, electroded, mounted on a PCB substrate and encapsulated as a superconducting grounding link. Additional powder also was used to prepare composites which were able to float a permanent magnet via the Meissner effect. Thin films prepared from nitrate and acetate precursors have been prepared using a dipping deposition process in conjunction with alumina and silver foil substrates. Thus far, the acetates appear to be the most promising. X-ray data indicate the proper crystalline structure for superconductivity, however, electrical measurements have not yet substantiated the existence of superconductivity in these films.

Finally, efforts to implement a COMMERCIAL USE OF SPACE program in superconductivity at LaRC have been completed and at least two industrial companies (AVX, Kodak) have indicated their interest in participating. This program should now move forward.